National Semiconductor

November 1994

NM27LV512
524,288-Bit (64k x 8) Low Voltage EPROM

General Description

The NM27LV512 is a high performance Low Voltage Electrical Programmable Read Only Memory. It is manufactured using National's latest 1.2μ CMOS split gate SVG EPROM technology. This technology allows the part to operate at speeds as fast as 200 ns over commercial temperature (0°C to 70°C), and 250 ns over industrial temperatures (−40°C to +85°C).

This Low Voltage and Low Power EPROM is designed with power sensitive handheld and portable battery products in mind. This allows for code storage of firmware for applications like notebook computers, palm top computers, cellular phones, and HDD.

National still maintains its commitment to high quality and reliability with EPI processing on the NM27LV512. Latch-up immunity is guaranteed for stresses up to 200 mA on address and data pins from −1V to V_{CC} + 0.3V. ESD protection is guaranteed to 2000V.

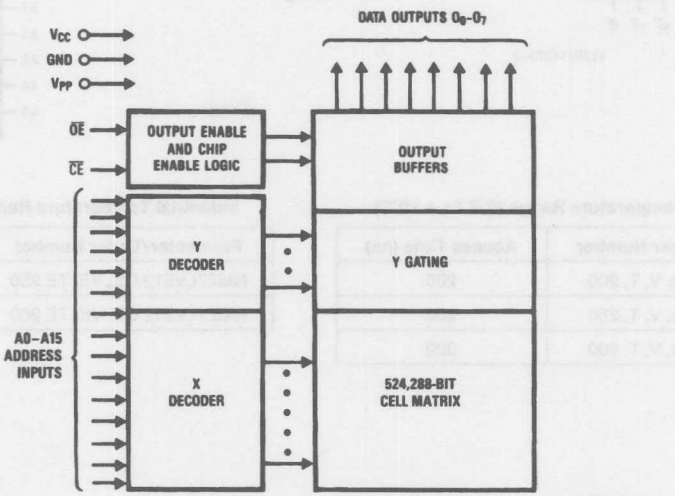
Small outline packages are just as critical to portable applications as Low Voltage and Low Power. National Semiconductor has forseen this need and provides windowed LCC for prototyping and software development, PLCC for production runs, and TSOP for PC board space sensitive users.

The NM27LV512 is one member of National's growing Low Voltage product family.

Features

- 3.0V to 3.6V operation
- 200 ns access time
- Low current operation
  - — 15 mA I_{CC} Active Current @ 5 MHz
  - — 20 μA I_{CC} Standby Current @ 5 MHz
- Ultra Low Power operation
  - — 50 μW Standby Power @ 3.3V
  - — 50 mW Active Power @ 3.3V
- Surface mount package options
  - — 32-pin PLCC
  - — 32-pin TSOP
  - — 28-pin DIP

Block Diagram



TL/D/11375–1

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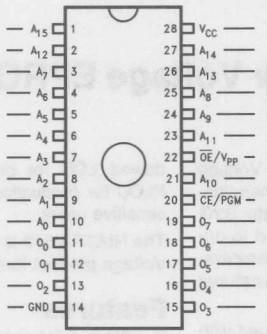
NSC800™ is a trademark of National Semiconductor Corporation.

RRD-B20M114/Printed in U. S. A.

Connection Diagrams

27C080	27C040	27C020	27C010	27C256
A_{19}	XX/V_{PP}	XX/V_{PP}	XX/V_{PP}	
A_{16}	A_{16}	A_{16}	A_{16}	
A_{15}	A_{15}	A_{15}	A_{15}	V_{PP}
A_{12}	A_{12}	A_{12}	A_{12}	A_{12}
A_7	A_7	A_7	A_7	A_7
A_6	A_6	A_6	A_6	A_6
A_5	A_5	A_5	A_5	A_5
A_4	A_4	A_4	A_4	A_4
A_3	A_3	A_3	A_3	A_3
A_2	A_2	A_2	A_2	A_2
A_1	A_1	A_1	A_1	A_1
A_0	A_0	A_0	A_0	A_0
O_0	O_0	O_0	O_0	O_0
O_1	O_1	O_1	O_1	O_1
O_2	O_2	O_2	O_2	O_2
GND	GND	GND	GND	GND

DIP
NM27LV512

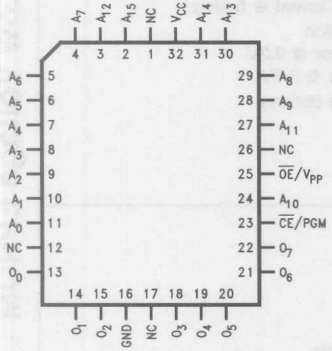


TL/D/11375–2

27C256	27C010	27C020	27C040	27C080
	V_{CC}	V_{CC}	V_{CC}	V_{CC}
	XX/$\overline{PGM}$	XX/$\overline{PGM}$	A_{18}	A_{18}
V_{CC}	XX	A_{17}	A_{17}	A_{17}
A_{14}	A_{14}	A_{14}	A_{14}	A_{14}
A_{13}	A_{13}	A_{13}	A_{13}	A_{13}
A_8	A_8	A_8	A_8	A_8
A_9	A_9	A_9	A_9	A_9
A_{11}	A_{11}	A_{11}	A_{11}	A_{11}
$\overline{OE}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}$	$\overline{OE}/V_{PP}$
A_{10}	A_{10}	A_{10}	A_{10}	A_{10}
$\overline{CE}/PGM$	$\overline{CE}$	$\overline{CE}$	$\overline{CE}/PGM$	$\overline{CE}/PGM$
O_7	O_7	O_7	O_7	O_7
O_6	O_6	O_6	O_6	O_6
O_5	O_5	O_5	O_5	O_5
O_4	O_4	O_4	O_4	O_4
O_3	O_3	O_3	O_3	O_3

Note: Compatible EPROM pin configurations are shown in the blocks adjacent to the NM27LV512 pins.

PLCC



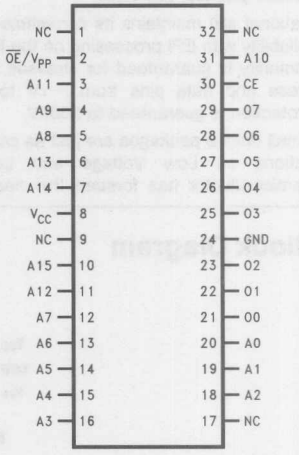
TL/D/11375–3

Pin Names

A0–A15	Addresses
$\overline{CE}$	Chip Enable
$\overline{OE}$	Output Enable
O0–O7	Outputs
$\overline{PGM}$	Program
XX	Don't Care (During Read)

Package Types: NM27LV512
Q = Ceramic DIP Package
V = PLCC Package
T = TSOP Package

TSOP



TL/D/11375–10

Commercial Temperature Range (0°C to +70°C)

Parameter/Order Number	Access Time (ns)
NM27LV512 Q, V, T, 200	200
NM27LV512 Q, V, T, 250	250
NM27LV512 Q, V, T, 300	300

Industrial Temperature Range (−40°C to +85°C)

Parameter/Order Number	Access Time (ns)
NM27LV512 QE, VE, TE 250	250
NM27LV512 QE, VE, TE 300	300

Absolute Maximum Ratings (Note 1)

If Military/Aerospace specified devices are required, please contact the National Semiconductor Sales Office/Distributors for availability and specifications.

Storage Temperature	−65°C to +150°C
All Input Voltages Except A9 with Respect to Ground	−0.6V to +7V
V_{PP} and A9 with Respect to Ground	−0.7V to +14V
V_{CC} Supply Voltage with Respect to Ground	−0.6V to +7V
ESD Protection (MIL Std. 883, Method 3015.2)	>2000V
All Output Voltages with Respect to Ground	V_{CC} + 1.0V to GND −0.6V

Operating Range

Range	Temperature	V_{CC}	Tolerance
Comm'l	0°C to +70°C	3.3V	±0.3V
Industrial	−40°C to +85°C	3.3V	±0.3V

Read Operation

DC Electrical Characteristics

Symbol	Parameter	Test Conditions		Min	Max	Units
V_{IL}	Input Low Level			−0.3	0.8	V
V_{IH}	Input High Level			2.0	V_{CC} + 0.3	V
V_{OL1}	Output Low Voltage (TTL)	I_{OL} = 2.0 mA			0.4	V
V_{OH1}	Output High Voltage (TTL)	I_{OH} = −2.0 mA		2.4		V
V_{OL2}	Output Low Voltage (CMOS)	I_{OL} = 100 µA			0.2	V
V_{OH2}	Output High Voltage (CMOS)	I_{OH} = −100 µA		V_{CC} − 0.3		V
I_{SB1}	V_{CC} Standby Current (CMOS)	$\overline{CE}$ = V_{CC} ±0.3V			20	µA
I_{SB2}	V_{CC} Standby Current (TTL)	$\overline{CE}$ = V_{IH}			500	µA
I_{CC1}	V_{CC} Active Current	$\overline{CE}$ = $\overline{OE}$ = V_{IL}	f = 5 MHz		15	mA
I_{CC2}	V_{CC} Active Current CMOS Inputs	$\overline{CE}$ = GND, f = 5 MHz Inputs = V_{CC} or GND, I/O = 0 mA C, I Temp Ranges			15	mA
I_{PP}	V_{PP} Supply Current	V_{PP} = V_{CC}			10	µA
V_{PP}	V_{PP} Read Voltage			V_{CC} − 0.7	V_{CC}	V
I_{LI}	Input Load Current	V_{IN} = 3.3V or GND		−1	1	µA
I_{LO}	Output Leakage Current	V_{OUT} = 3.3V or GND		−1	10	µA

AC Electrical Characteristics

Symbol	Parameter	200		250		300		Units
		Min	Max	Min	Max	Min	Max	
t_{ACC}	Address to Output Delay		200		250		300	ns
t_{CE}	$\overline{CE}$ to Output Delay		200		250		300	
t_{OE}	$\overline{OE}$ to Output Delay		75		100		120	
t_{DF}	Output Disable to Output Float	0	60	0	60	0	105	
t_{OH}	Output Hold from Addresses, $\overline{CE}$ or $\overline{OE}$, Whichever Occurred First	0		0		0		

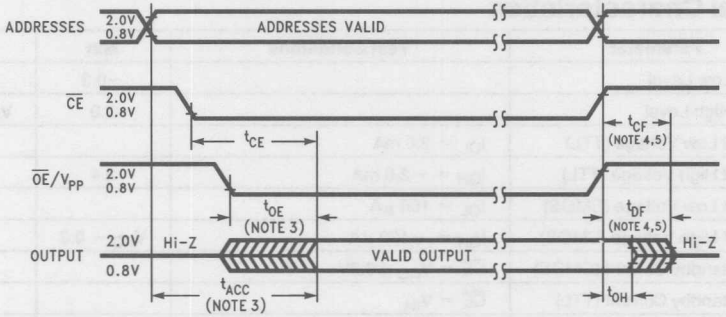
Capacitance $T_A = +25°C$, f = 1 MHz (Note 2)

Symbol	Parameter	Conditions	Typ	Max	Units
C_{IN1}	Input Capacitance except $\overline{OE}/V_{PP}$	$V_{IN} = 0V$	6	12	pF
C_{OUT}	Output Capacitance	$V_{OUT} = 0V$	9	12	pF
C_{IN2}	$\overline{OE}/V_{PP}$ Input Capacitance	$V_{IN} = 0V$	20	25	pF

AC Test Conditions

Output Load	1 TTL Gate and $C_L = 100$ pF (Note 8)
Input Rise and Fall Times	≤5 ns
Input Pulse Levels	0.45V to 2.4V
Timing Measurement Reference Level (Note 9)	
Inputs	0.8V and 2V
Outputs	0.8V and 2V

AC Waveforms (Notes 6, 7)



TL/D/11375–5

Note 1: Stresses above those listed under "Absolute Maximum Ratings" may cause permanent damage to the device. This is a stress rating only and functional operation of the device at these or any other conditions above those indicated in the operational sections of this specification is not implied. Exposure to absolute maximum rating conditions for extended periods may affect device reliability.

Note 2: This parameter is only sampled and is not 100% tested.

Note 3: $\overline{OE}$ may be delayed up to $t_{ACC} - t_{OE}$ after the falling edge of $\overline{CE}$ without impacting t_{ACC}.

Note 4: The t_{DF} and t_{CF} compare level is determined as follows:
High to TRI-STATE, the measured V_{OH1} (DC) − 0.10V;
Low to TRI-STATE, the measured V_{OL1} (DC) + 0.10V.

Note 5: TRI-STATE may be attained using $\overline{OE}$ or $\overline{CE}$.

Note 6: The power switching characteristics of EPROMs require careful device decoupling. It is recommended that at least a 0.1 μF ceramic capacitor be used on every device between V_{CC} and GND.

Note 7: The outputs must be restricted to V_{CC} + 1.0V to avoid latch-up and device damage.

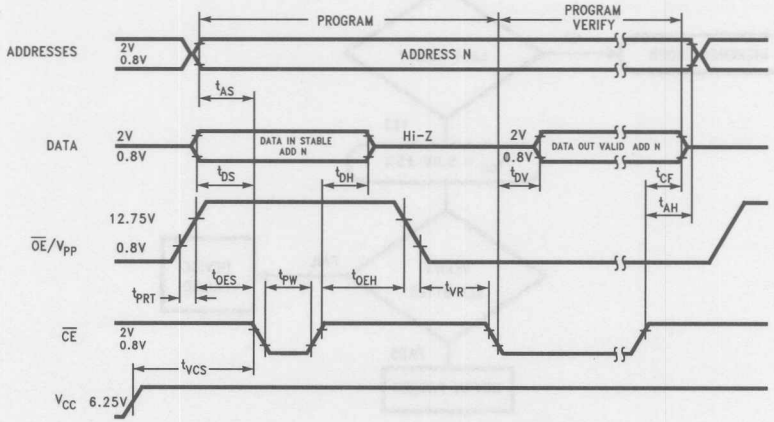
Note 8: 1 TTL Gate: $I_{OL} = 1.6$ mA, $I_{OH} = -400$ μA.
C_L: 100 pF includes fixture capacitance.

Note 9: Inputs and outputs can undershoot to −2.0V for 20 ns Max.

Programming Characteristics (Notes 1 and 2)

Symbol	Parameter	Conditions	Min	Typ	Max	Units
t_{AS}	Address Setup Time		1			μs
t_{OES}	$\overline{OE}$ Setup Time		1			μs
t_{DS}	Data Setup Time		1			μs
t_{VCS}	V_{CC} Setup Time		1			μs
t_{AH}	Address Hold Time		0			μs
t_{DH}	Data Hold Time		1			μs
t_{CF}	Chip Enable to Output Float Delay	$\overline{OE} = V_{IL}$	0		60	ns
t_{PW}	Program Pulse Width		95	100	105	μs
t_{OEH}	$\overline{OE}$ Hold Time		1			μs
t_{DV}	Data Valid from $\overline{CE}$	$\overline{OE} = V_{IL}$			250	ns
t_{PRT}	$\overline{OE}$ Pulse Rise Time during Programming		50			ns
t_{VR}	V_{PP} Recovery Time		1			μs
I_{PP}	V_{PP} Supply Current during Programming Pulse	$\overline{CE} = V_{IL}$ $\overline{OE} = V_{PP}$			30	mA
I_{CC}	V_{CC} Supply Current				50	mA
T_R	Temperature Ambient		20	25	30	°C
V_{CC}	Power Supply Voltage		6	6.25	6.5	V
V_{PP}	Programming Supply Voltage		12.5	12.75	13	V
t_{FR}	Input Rise, Fall Time		5			ns
V_{IL}	Input Low Voltage			0	0.45	V
V_{IH}	Input High Voltage		2.4	4		V
t_{IN}	Input Timing Reference Voltage		0.8		2	V
t_{OUT}	Output Timing Reference Voltage		0.8		2	V

Programming Waveforms



TL/D/11375–6

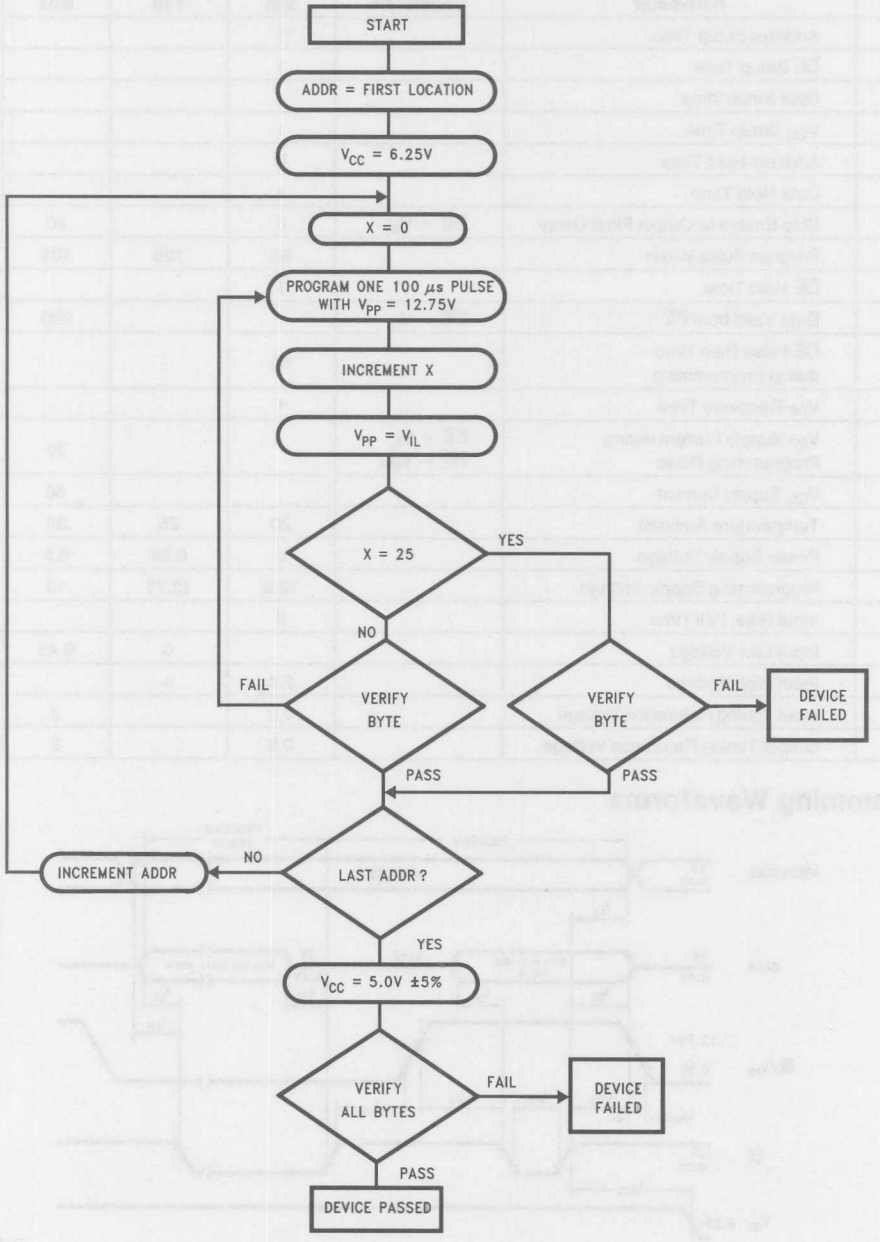
Note 1: National's standard product warranty applies to devices programmed to specifications described herein.

Note 2: V_{CC} must be applied simultaneously or before V_{PP} and removed simultaneously or after V_{PP}. The EPROM must not be inserted into or removed from a board with voltage applied to V_{PP} or V_{CC}.

Note 3: The maximum absolute allowable voltage which may be applied to the V_{PP} pin during programming is 14V. Care must be taken when switching the V_{PP} supply to prevent any overshoot from exceeding this 14V maximum specification. At least a 0.1 μF capacitor is required across V_{CC} to GND to suppress spurious voltage transients which may damage the device.

Note 4: Programming and program verify are tested with the fast Program Algorithm at typical power supply voltages and timings.

Fast Programming Algorithm Flow Chart



TL/D/11375–7

FIGURE 1

Functional Description

DEVICE OPERATION

The six modes of operation of the EPROM are listed in Table I. It should be noted that all inputs for the six modes are at TTL levels. The power supplies required are V_{CC} and $\overline{OE}/V_{PP}$. The $\overline{OE}/V_{PP}$ power supply must be at 12.75V during the three programming modes, and must be at 3.3V in the other three modes. The V_{CC} power supply must be at 6.25V during the three programming modes, and at 3.3V in the other three modes.

Read Mode

The EPROM has two control functions, both of which must be logically active in order to obtain data at the outputs. Chip Enable ($\overline{CE}$) is the power control and should be used for device selection. Output Enable ($\overline{OE}/V_{PP}$) is the output control and should be used to gate data to the output pins, independent of device selection. Assuming that addresses are stable, address access time (t_{ACC}) is equal to the delay from $\overline{CE}$ to output (t_{CE}). Data is available at the outputs t_{OE} after the falling edge of $\overline{OE}$, assuming that $\overline{CE}$ has been low and addresses have been stable for at least $t_{ACC}-t_{OE}$.

Standby Mode

The EPROM has a standby mode which reduces the active power dissipation by over 99%, from 44 mW to 110 μW. The EPROM is placed in the standby mode by applying a CMOS high signal to the $\overline{CE}$ input. When in standby mode, the outputs are in a high impedance state, independent of the $\overline{OE}$ input.

Output Disable

The EPROM is placed in output disable by applying a TTL high signal to the $\overline{OE}$ input. When in output disable all circuitry is enabled, except the outputs are in a high impedance state (TRI-STATE).

Output OR-Tying

Because the EPROM is usually used in larger memory arrays, National has provided a 2-line control function that accommodates this use of multiple memory connections. The 2-line control function allows for:

a) the lowest possible memory power dissipation, and

b) complete assurance that output bus contention will not occur.

To most efficiently use these two control lines, it is recommended that $\overline{CE}$ be decoded and used as the primary device selecting function, while $\overline{OE}/V_{PP}$ be made a common connection to all devices in the array and connected to the READ line from the system control bus.

This assures that all deselected memory devices are in their low power standby modes and that the output pins are active only when data is desired from a particular memory device.

Programming

CAUTION: Exceeding 14V on pin 22 ($\overline{OE}/V_{PP}$) will damage the EPROM.

Initially, and after each erasure, all bits of the EPROM are in the "1's" state. Data is introduced by selectively programming "0's" into the desired bit locations. Although only "0's" will be programmed, both "1's" and "0's" can be presented in the data word. The only way to change a "0" to a "1" is by ultraviolet light erasure.

The EPROM is in the programming mode when the OE/V_{PP} is at 12.75V. It is required that at least a 0.1 μF capacitor be placed across V_{CC} to ground to suppress spurious voltage transients which may damage the device. The data to be programmed is applied 8 bits in parallel to the data output pins. The levels required for the address and data inputs are TTL.

When the address and data are stable, an active low, TTL program pulse is applied to the $\overline{CE}$ input. A program pulse must be applied at each address location to be programmed.

The EPROM is programmed with the Fast Programming Algorithm shown in *Figure 1*. Each Address is programmed with a series of 100 μs pulses until it verifies good, up to a maximum of 25 pulses. Most memory cells will program with a single 100 μs pulse.

The EPROM must not be programmed with a DC signal applied to the $\overline{CE}$ input.

Programming multiple EPROM in parallel with the same data can be easily accomplished due to the simplicity of the programming requirements. Like inputs of the parallel EPROM may be connected together when they are programmed with the same data. A low level TTL pulse applied to the $\overline{CE}$ input programs the paralleled EPROM.

Program Inhibit

Programming multiple EPROMs in parallel with different data is also easily accomplished. Except for $\overline{CE}$ all like inputs (including $\overline{OE}/V_{PP}$) of the parallel EPROMs may be common. A TTL low level program pulse applied to an EPROM's $\overline{CE}$ input with $\overline{OE}/V_{PP}$ at 12.75V will program that EPROM. A TTL high level $\overline{CE}$ input inhibits the other EPROMs from being programmed.

Functional Description (Continued)

Program Verify

A verify should be performed on the programmed bits to determine whether they were correctly programmed. The verify is accomplished with $\overline{OE}/V_{PP}$ and $\overline{CE}$ at V_{IL}. Data should be verified T_{DV} after the falling edge of $\overline{CE}$.

AFTER PROGRAMMING

Opaque labels should be placed over the EPROM window to prevent unintentional erasure. Covering the window will also prevent temporary functional failure due to the generation of photo currents.

MANUFACTURER'S IDENTIFICATION CODE

The EPROM has a manufacturer's identification code to aid in programming. When the device is inserted in an EPROM programmer socket, the programmer reads the code and then automatically calls up the specific programming algorithm for the part. This automatic programming control is only possible with programmers which have the capability of reading the code.

The Manufacturer's Identification code, shown in Table II, specifically identifies the manufacturer and device type. The code for NM27LV512 is "8F85", where "8F" designates that it is made by National Semiconductor, and "85" designates a 512k part.

The code is accessed by applying 12V $\pm$0.5V to address pin A9. Addresses A1–A8, A10–A15, and all control pins are held at V_{IL}. Address pin A0 is held at V_{IL} for the manufacturer's code, and held at V_{IH} for the device code. The code is read on the eight data pins, O_0–O_7. Proper code access is only guaranteed at 25°C $\pm$5°C.

ERASURE CHARACTERISTICS

The erasure characteristics of the device are such that erasure begins to occur when exposed to light with wavelengths shorter than approximately 4000 Angstroms (Å). It should be noted that sunlight and certain types of fluorescent lamps have wavelengths in the 3000Å–4000Å range.

The recommended erasure procedure for the EPROM is exposure to short wave ultraviolet light which has a wavelength of 2537Å. The integrated dose (i.e., UV intensity $\times$ exposure time) for erasure should be minimum of 15W-sec/cm^2.

The EPROM should be placed within 1 inch of the lamp tubes during erasure. Some lamps have a filter on their tubes which should be removed before erasure.

An erasure system should be calibrated periodically. The distance from lamp to device should be maintained at one inch. The erasure time increase as the square of the distance from the lamp (if distance is doubled the erasure time increases by factor of 4). Lamps lose intensity as they age. When a lamp is changed, the distance has changed, or the lamp has aged, the system should be checked to make certain full erasure is occurring. Incomplete erasure will cause symptoms that can be misleading. Programmers, components, and even system designs have been erroneously suspected when incomplete erasure was the problem.

SYSTEM CONSIDERATION

The power switching characteristics of EPROMs require careful decoupling of the devices. The supply current, I_{CC}, has three segments that are of interest to the system designer: the standby current level, the active current level, and the transient current peaks that are produced by voltage transitions on input pins. The magnitude of these transient current peaks is dependent of the output capacitance loading of the device. The associated V_{CC} transient voltage peaks can be suppressed by properly selected decoupling capacitors. It is recommended that at least a 0.1 μF ceramic capacitor be used on every device between V_{CC} and GND. This should be a high frequency capacitor of low inherent inductance. In addition, at least a 4.7 μF bulk electrolytic capacitor should be used between V_{CC} and GND for each eight devices. The bulk capacitor should be located near where the power supply is connected to the array. The purpose of the bulk capacitor is to overcome the voltage drop caused by the inductive effects of the PC board traces.

Mode Selection

The modes of operation of the NM27LV512 are listed in Table I. A single 3.3V power supply is required in the read mode. All inputs are TTL levels excepts for V_{PP} and A9 for device signature.

TABLE I. Mode Selection

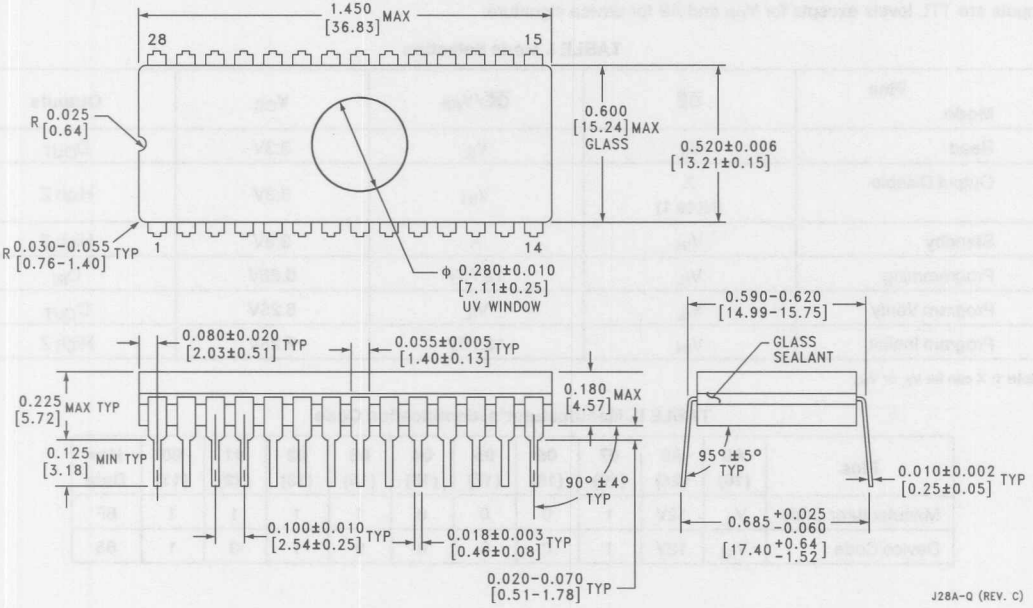
Mode \ Pins	$\overline{CE}$	$\overline{OE}/V_{PP}$	V_{CC}	Outputs
Read	V_{IL}	V_{IL}	3.3V	D_{OUT}
Output Disable	X (Note 1)	V_{IH}	3.3V	High Z
Standby	V_{IH}	X	3.3V	High Z
Programming	V_{IL}	12.75V	6.25V	D_{IN}
Program Verify	V_{IL}	V_{IL}	6.25V	D_{OUT}
Program Inhibit	V_{IH}	12.75V	6.25V	High Z

Note 1: X can be V_{IL} or V_{IH}.

TABLE II. Manufacturer's Identification Code

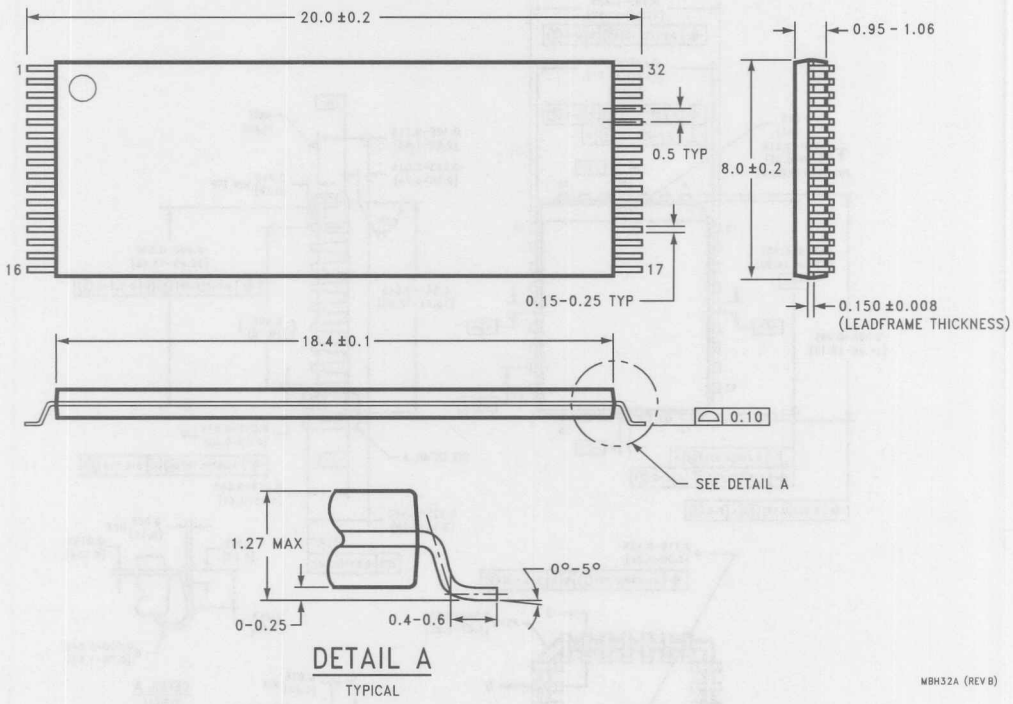
Pins	A0 (10)	A9 (24)	07 (19)	06 (18)	05 (17)	04 (16)	03 (15)	02 (13)	01 (12)	00 (11)	Hex Data
Manufacturer Code	V_{IL}	12V	1	0	0	0	1	1	1	1	8F
Device Code	V_{IH}	12V	1	0	0	0	0	1	0	1	85

Physical Dimensions inches (millimeters)



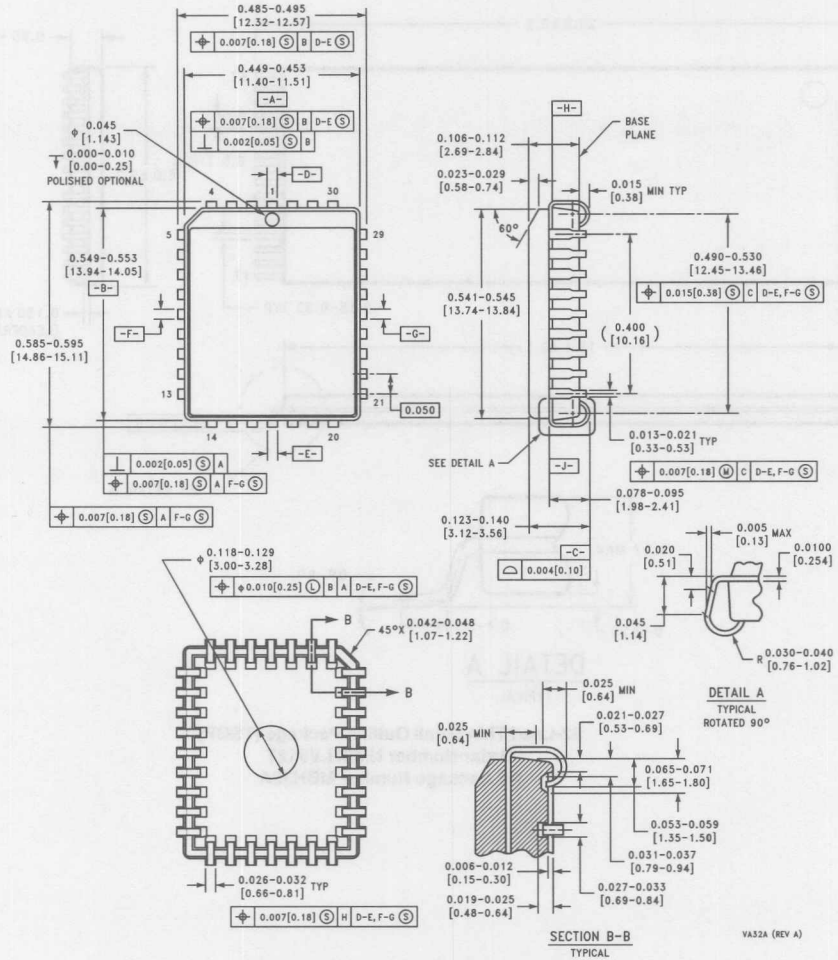
28-Pin Ceramic DIP (Q)
Order Number NM27LV512Q
NS Package Number J28AQ

Physical Dimensions inches (millimeters) (Continued)



32-Lead Thin Small Outline Package (TSOP)
Order Number NM27LV512T
NS Package Number MBH32A

Physical Dimensions inches (millimeters) (Continued)



32-Lead Plastic Leaded Chip Carrier (V)
Order Number NM27LV512V
NS Package Number VA32A

LIFE SUPPORT POLICY

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1. Life support devices or systems are devices or systems which, (a) are intended for surgical implant into the body, or (b) support or sustain life, and whose failure to perform, when properly used in accordance with instructions for use provided in the labeling, can be reasonably expected to result in a significant injury to the user.
2. A critical component is any component of a life support device or system whose failure to perform can be reasonably expected to cause the failure of the life support device or system, or to affect its safety or effectiveness.

National Semiconductor Corporation
2900 Semiconductor Drive
P.O. Box 58090
Santa Clara, CA 95052-8090
Tel: 1(800) 272-9959
TWX: (910) 339-9240

National Semiconductor GmbH
Industriestrasse 10
D-82256 Fürstenfeldbruck
Germany
Tel: (0-81-41) 103-0
Telex: 527649
Fax: (0-81-41) 10-35-06

National Semiconductor Japan Ltd.
Sumitomo Chemical
Engineering Center
Bldg. 7F
1-7-1, Nakase, Mihama-Ku
Chiba-City,
Ciba Prefecture 261
Tel: (043) 299-2300
Fax: (043) 299-2500

National Semiconductor Hong Kong Ltd.
13th Floor, Straight Block
Ocean Centre, 5 Canton Rd.
Tsimshatsui, Kowloon
Hong Kong
Tel: (852) 737-1600
Telex: 51292 NSHKL
Fax: (852) 736-9960

National Semiconductores Do Brazil Ltda.
Rue Deputado Lacorda Franco
120-3A
Sao Paulo-SP
Brazil 05418-000
Tel: (55-11) 212-5066
Telex: 391-1131931 NSBR BR
Fax: (55-11) 212-1181

National Semiconductor (Australia) Pty, Ltd.
16 Business Park Dr.
Notting Hill, VIC 3168
Australia
Tel: (3) 558-9999
Fax: (3) 558-9998